



# 1M30P

**DS-11-01M30**

**DS-12-01M30**

**DS-14-01M30**

**30 fps 1k x 1k**

**CCD Camera**



**User's Manual and Reference**

**Doc #: 03-32-10001**

**Rev: 02**



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DALSA specializes in the manufacture, design, research and development of high performance digital imaging solutions. The DALSTAR 1M30P is part of a product line that provides the highest spatial resolution at the highest data transfer speed of any known products in the industry. DALSA's image sensors and cameras are used worldwide in document scanning, image capture, surveillance, process monitoring and manufacturing inspection. DALSA also develops customized products for specific customers and applications.

All DALSA products are manufactured using the latest state-of-the-art equipment to ensure product reliability.

DALSTAR refers to all DALSA area scan products.

For further information not included in this manual, or for information on DALSA's extensive line of image sensing products, please contact us.

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# 1

## Introduction to the 1M30P Camera

### 1.0 Camera Highlights



#### Features

- 1024 x 1024 resolution, Frame Transfer CCD architecture (on-chip storage region).
- 30 fps one output at full resolution, 40 MHz data rate
- True 12-bit digitization
- High sensitivity with low dark current
- Progressive scan readout
- On-chip shutter
- Asynchronous image capture, externally triggerable to within 200 ns.
- Selectable binning up to 8 x 8
- Programmable operation via RS232, including gain (1x to 10x) , offset ( $\pm$  full scale), frame rate, binning, and triggering.
- 100% fill factor

#### Description

The 1M30P digital camera provides high-sensitivity 12-bit images with 1k x 1k spatial resolution at up to 30 frames per second (fps). The 1M30P is a frame transfer CCD camera using a progressive scan CCD to simultaneously achieve outstanding resolution and gray scale characteristics. A square pixel format and high fill factor provide superior, quantifiable image quality even at low light levels.

#### Applications

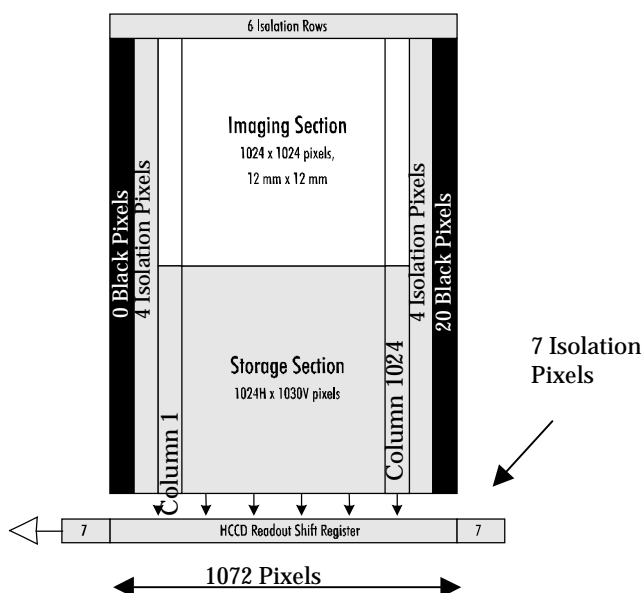
The 1M30P is an outstanding performer in fast, very high resolution applications. True 12 bit performance provides up to 4096 distinct gray levels—perfect for applications with

large interscene light variations. The low-noise, digitized video signal also makes the camera an excellent choice where low contrast images must be captured in challenging applications.

## 1.2 Image Sensor

The 1M30 uses DALSA's IA-D4 high-performance frame transfer CCD.

**Figure 1: Image Sensor Block Diagram**



**Note:** If you are using DS-14-01M30, these cosmetic specifications do not apply.

**Table 1: Sensor Cosmetic Specifications**

Specification	Grade 01
a) Number of first and last columns excluded	16
b) Number of first and last rows excluded	16
c) Maximum quantity of single pixel blemishes	—
d) Maximum quantity of cluster blemishes	15
e) Maximum size of clusters (adjacent pixels)	5
f) Blemish pixel deviation from $V_{FLL}$ * under illumination	0
g) Blemish pixel deviation from $V_{FLL}$ * under illumination	> 10 % < 30 %
h) Blemish pixel deviation from average dark level, measured at dark	>20mV

\*V<sub>FLL</sub> is defined as the output signal under broadband quartz tungsten halogen light with an irradiance of 3.41  $\mu\text{W}/\text{cm}^2$ .

1. All sensors are tested in dual output mode.
2. Blemish variations are measured over an entire frame of data and counted within the frame boundaries defined by a) and b).

3. Blemishes are defined as a pixel or group of pixels with an output as defined in g) or h).
4. Clusters are defined as a pixel or group of pixel blemishes, and are allowed, provided they are smaller or equal to the sizes specified in e).
5. Illuminated blemish analysis done at 70% of  $V_{FLL}$  ( $2.39\mu W/cm^2$ ).
6. Grade 00 and 01 blemishes are not permitted to vary by more than 30 % of  $V_{FLL}$ . The result is that uniformity is better than grade 02 or 03 (no full white or black pixels).
7. A blemished column is defined as a column containing greater than 40 pixels outside the blemish specification g) and/or h).
8. Column and row defects not permitted.
9. Better than grade 01 sensors may be available. Please contact DALSA sales if interested.

## 1.3 Camera Performance Specifications

Table 2: 1M30P Camera Performance Specifications

Physical Characteristics	Units				
Resolution	H x V pixels	1024 x 1024			
Pixel Size	$\mu m$	12x12			
Pixel Fill Factor	%	100			
Size	mm	92 x 92 x 144			
Mass	kg	0.85			
Power Dissipation	W	< 11			
Lens Mount		C or F mount			
Aperture	mm	12.3 x 12.3			
Regulatory Compliance		Pending			
Shock Immunity		Pending			
Vibration Immunity		Pending			
Operating Ranges	Units	Min.	Max.		
Frame Rate	fps	3.815	129		
Data Rate	MHz	5	40		
Data Format	LVDS		12 bit		
Responsivity	DN/(nJ/ $cm^2$ )		24@540nm		
Operating Temp	$^{\circ}C$	10	45		
+15 Input Voltage	V	+14.925	+15.075		
+5 Input Voltage	V	+4.975	+5.025		
-5 Input Voltage	V	- 4.975	- 5.025		
Nominal Gain Range		1x	10x		

Calibration Conditions	Units	Setting	Min.	Max.	
Data Rate	MHz	40	40	40	
Frame Rate	Hz	30	30	30	
+15 Input Voltage	V	+15	+14.925	+15.075	
+5 Input Voltage	V	+5	+4.975	+5.025	
-5 Input Voltage	V	- 5	- 4.975	- 5.025	
Ambient Temperature	°C	25			
Binning		1x1			
Gain	X	1x			
Integration Time	ms	31.173			
Electro-Optical Specifications	Units	Min.	Typical	Max.	
Dynamic Range	dB		68		
Pixel Response Non-Uniformity	%rms			5.0	
System Noise	DN(rms)		1.5		

# 2

---

## Camera Hardware Interface

### 2.1 Installation Overview

This installation overview assumes you have not installed any system components yet.

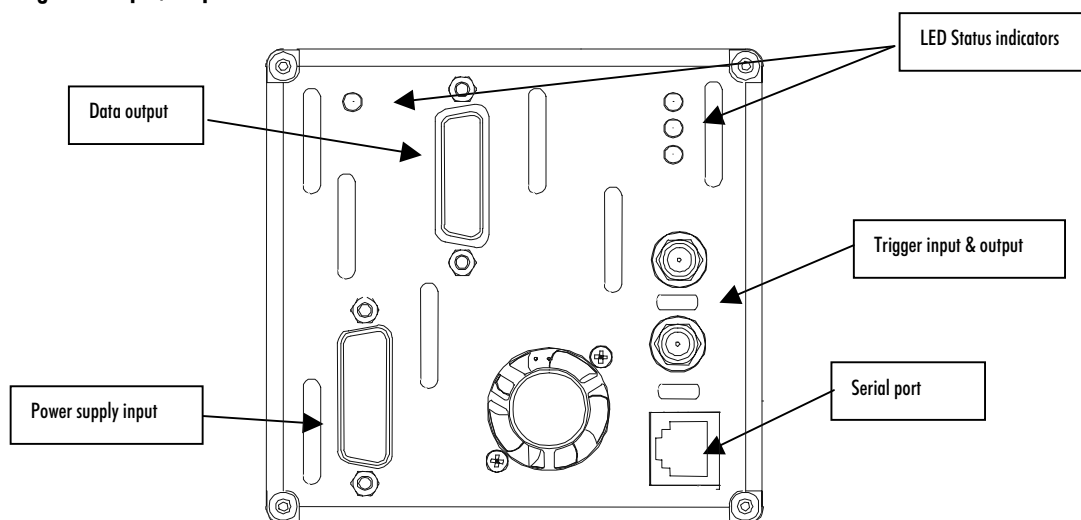
In order to set up your camera, you should take these initial steps:

1. Power down all equipment.
2. Following the manufacturer's instructions, install the frame grabber (if applicable). **Be sure to observe all static precautions.**
3. Install any necessary imaging software.
4. Before connecting power to the camera, test all power supplies. **Ensure that all the correct voltages are present at the camera end of the power cable** (the Camera Performance Specifications earlier in this document list appropriate voltages). Power supplies must meet the requirements defined in section 2.4 Power Input.
5. Inspect all cables and connectors prior to installation. Do not use damaged cables or connectors or the camera may be damaged.
6. Connect data, serial interface, and power cables.
7. After connecting cables, apply power to the camera. The POST (power on self test) LED on the back of the camera should glow green after one second to indicate that the camera is operating and ready to receive commands.

### 2.2 Input/Output

The camera provides 12-bit LVDS data and synchronization signals through the data output connector. Camera functions such as frame rate, integration time, binning, camera gain and offset are all controllable by the user via RS232 serial port. The camera is capable of free running operation or may be triggered externally via the input TRIGGER IN. TRIGGER OUT allows the synchronization of shutters or illumination sources in free running or externally triggered modes.

Figure 2: Input/Output



## 2.3 LED Status Indicators

There are four LED's visible on the rear cover of the camera that indicate the status of the camera.

Table 3: LED Functions

LED Label	Color	LED "ON"	LED "OFF"
ON	Green	Camera is receiving power	There is no camera power
POST	Green	Camera Power On Self Test successful	Camera failed Power On Self Test
BIN	Green	Camera is operating in a binning mode	Camera is operating unbinned (1x1)
MODE	Green	Camera is in an external trigger mode (uses external signal to trigger image capture)	Camera is triggering image capture internally

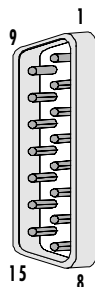
## 2.4 Power Input



**WARNING:** It is extremely important that you apply the appropriate voltages to your camera. Incorrect voltages will damage the camera.

Table 4: Power Connector Pinout

Pin	Symbol
1	+5V
2	+5V
3	- 5V
4	+15V
5	NC
6	NC
7	GND
8	GND
9	+5V
10	- 5V
11	+15V
12	NC
13	NC
14	GND
15	GND



**DB15M**  
(AMP Part # 747236-4  
or equivalent)

The camera has the following input power requirements.

V (DC)	±%	Max Ripple mV	A
+15	0.5	< 5	0.16
+5	0.5	< 5	1.60
-5	0.5	< 5	0.15

**Note:** Performance specifications are not guaranteed if your power supply does not meet these requirements.

DALSA offers a linear power supply (with cables) that meets the 1M30P's requirements (Universal Power Supply, part number 24-00001-02, contact DALSA for more information), but it should not be considered the only choice. Many high quality supplies are available from other vendors. DALSA assumes no responsibility for the use of these supplies.

When setting up the camera's power supplies, follow these guidelines:

- Do not connect or disconnect cable while power is on.
- Do not use the shield on a multi-conductor cable for ground.
- Keep leads as short as possible to reduce voltage drop.
- Use high-quality **linear** supplies to minimize noise.

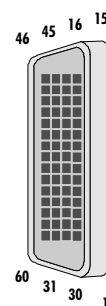
## 2.5 Data Output

The camera back panel output connector DATA utilizes differential LVDS signals with pin assignments as follows:

### Connector and Pinout

Table 5: DATA Connector Pinout

Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol
1	DA0+	16	Reserved	31	NC	46	GND
2	DA0-	17	DA7+	32	NC	47	NC
3	DA1+	18	DA7-	33	NC	48	NC
4	DA1-	19	DA8+	34	NC	49	NC
5	DA2+	20	DA8-	35	NC	50	NC
6	DA2-	21	DA9+	36	NC	51	NC
7	DA3+	22	DA9-	37	NC	52	NC
8	DA3-	23	DA10+	38	NC	53	Reserved
9	DA4+	24	DA10-	39	NC	54	Reserved
10	DA4-	25	DA11+	40	NC	55	VSYNC-
11	DA5+	26	DA11-	41	NC	56	VSYNC+
12	DA5-	27	NC	42	NC	57	HSYNC-
13	DA6+	28	NC	43	NC	58	HSYNC+
14	DA6-	29	NC	44	NC	59	PIXCLK-
15	Reserved	30	NC	45	GND	60	PIXCLK+



(Molex Part # 70928-2000 or equivalent)

NC = No Connect. These pins are unused.



**WARNING.** Care must be taken when connecting Data cables to the camera to insure proper connection and to prevent damage to the connector.

### Data Signals

Table 6: Data Signal Definition

Signal	Description
DA0+, DA0-	Data bit 0 true and complement--Output. (Least significant bit)
DA1+, DA1-	Data bit 1 true and complement--Output.
DA2+, DA2-	Data bit 2 true and complement--Output.
DA3-DA10+,- etc.	Etc.
DA11+, DA11-	Data bit 11 true and complement--Output. (Most significant bit)

Digitized video data is output from the camera as LVDS differential signals using a Molex 60-pin connector on the rear panel (labeled “DATA”). The data is synchronous and is accompanied by a pixel clock and clocking signals.

**Note:** Data frequency is dependent on binning mode. Reference section 3.12 – Triggering, Integration, and Frame Rate Overview.



**IMPORTANT:**  
This camera uses the *falling* edge of the pixel clock to register data.

## Data Clocking Signals

Table 7: Clock Signal Descriptions

Signal	Description
PIXCLK+, PIXCLK-	Pixel clock true and complement. 40 MHz (unbinned) -- Output. Data is valid on the falling edge. Note that data and PIXCLK frequency is dependent on binning mode. Reference section 3.12 – Triggering, Integration, and Frame Rate Overview
HSYNC+, HSYNC-	Horizontal sync, true and complement--Output. HSYNC high indicates the camera is outputting a valid line of data. The number of valid lines in a frame depends on binning mode. Reference section 3.12 – Triggering, Integration, and Frame Rate Overview.
VSYSN+, VSYSN-	Vertical sync, true and complement--Output. VSYSN high indicates the camera is outputting a valid frame of data.

## 2.6 Serial Communication

### Connector and Pinout

The serial interface provides control of frame rate, integration time (shuttering), video gain and offset, pixel binning, external trigger and external integration (for information on how to control these functions, see “Operating the Camera” later in this document). The remote interface consists of a two-wire (plus ground) full duplex RS-232 compatible serial link, used for camera configuration, and two back panel SMA coax connectors used for external trigger input and output

The camera uses an RJ-11 telephone-style connector for communications, with four conductors installed in a six-position connector. Note that both four- and six-conductor plugs may be used interchangeably with the RJ-11 jack.

**IMPORTANT:** Both the PC/AT and the camera are configured as “DTE” (Data Terminal Equipment) devices requiring the TXD and RXD lines to be swapped when interconnecting the two (note that pin 4, normally the yellow wire, is not used on the RJ-11.) That is, the TXD pin represents DATA OUT and the RXD pin represents DATA IN on both devices, so that one device's TXD line must connect to the other device's RXD line and vice-versa.

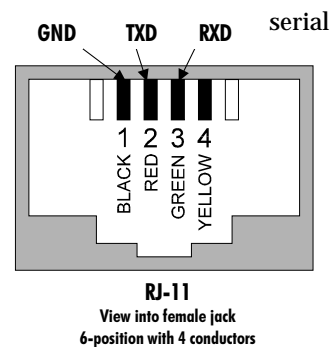


Figure 3: 25 Pin Serial Port Connector to Camera RJ-11 Connector

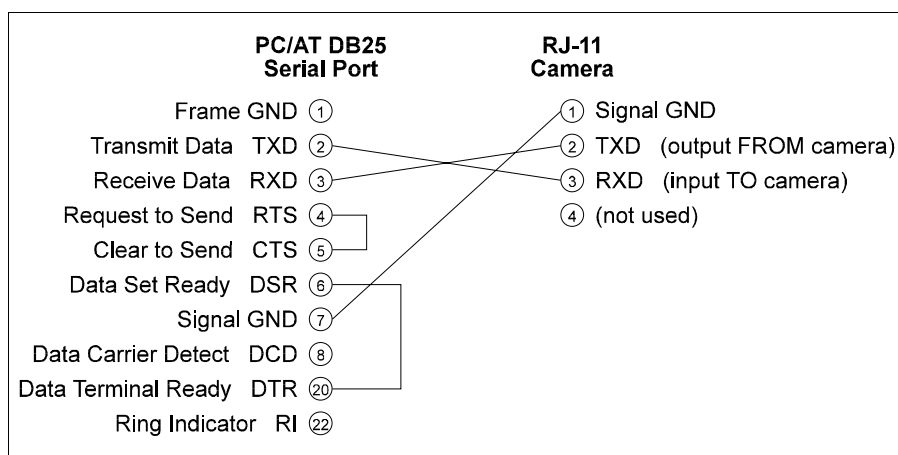
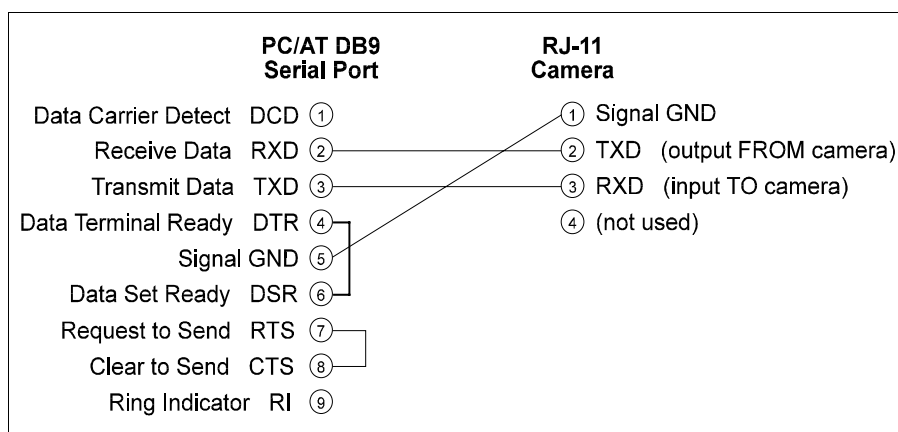


Figure 4: 9 Pin Serial Port Connector to Camera RJ-11 Connector



## Serial Communication Settings

### Serial Port Configuration

Baud	9600, fixed
Start bits	1
Data bits	8
Stop bits	1
Parity	None

The serial interface operates at RS-232 levels with fixed parameters of 9600 baud, 1 start bit, 8 data bits, 1 stop bit, and no parity. The interface uses only three wires, for received data, transmitted data, and ground. In general writing data must start with a write command byte and be followed by a data byte. Reading a camera register requires only a single read command byte.



**WARNING:** Due to initialization sequencing after power-up, no commands should be sent to the camera for a minimum of 1 second after power up.

The remote interface connector, on the camera's rear panel, is specified as a low-profile RJ-11 modular connector. The connector is a 6-position model, but only the center four positions are populated with contacts. It will mate with either the 4-position or 6-position cable plugs. This type of connector typically requires special assembly tools; complete cable assemblies are available from suppliers such as Digi-Key:

#### Serial Cable Source

##### Digi-Key

701 Brooks Ave. South  
Thief River Falls, MN 56701  
1-800-344-4539  
cable part number:  
H2643-14-ND (14 feet)

DALSA provides serial cables in 3 lengths: 10', 20' and 50'. Part number CL-31-00004-xx (where xx refers to the cable length in feet). Other lengths may be available – please check with DALSA sales.

## 2.7 TTL Trigger Input and Output

### Connector

The camera uses an SMA connector (labeled TRIGGER IN) to allow the user to provide a standard TTL signal to control camera integration and readout. The input is high impedance ( $>10K$ ) allowing the user to terminate at the SMA input as needed. The camera has another SMA connector (TRIGGER OUT) that provides a standard TTL output which is high whenever the camera is integrating.

Figure 5: External Integration Timing Description

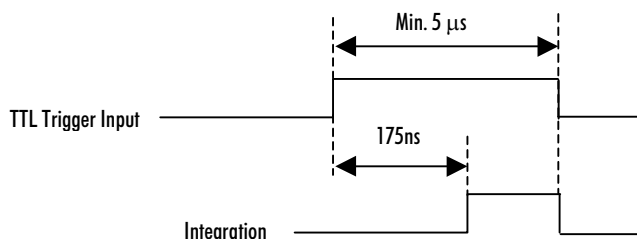
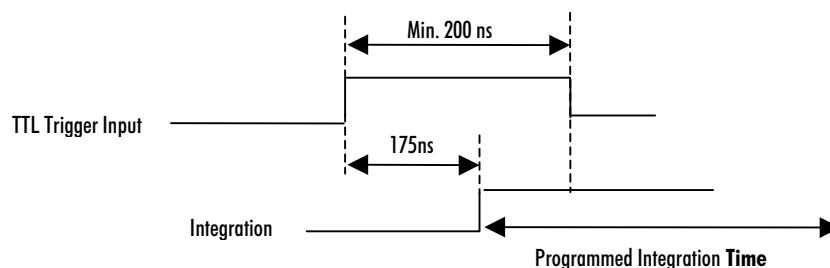


Figure 6: Programmed Integration Trigger Timing Description



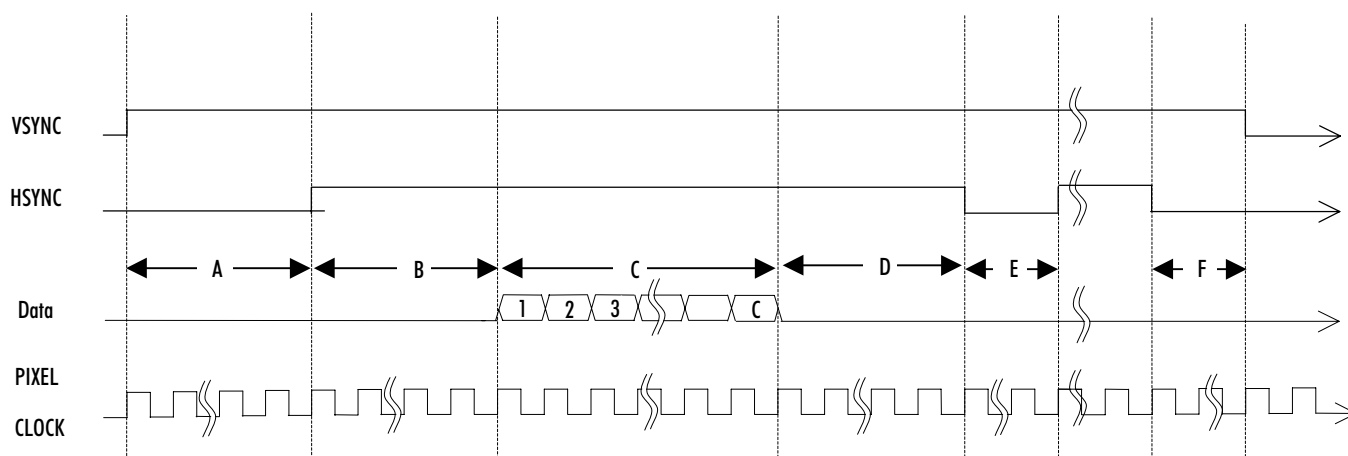
## 2.8 Integration Time

The minimum integration time (or shutter time) is 5  $\mu$ s. If the camera is not strobed or externally shuttered, an integration time of 5  $\mu$ s will create smeared images. To reduce smearing, the integration time should be 1.5x to 2x the readout time when not using a strobe or external shutter.

## 2.9 Timing

The 1M30P pixel clock runs at 40 MHz, so each pixel clock cycle will be 1/40,000,000 or 25 ns. The following diagram and tables describe the correct timing requirements for the 1M30P camera.

Figure 7: 1M30P Timing



**IMPORTANT:**  
This camera uses the *falling* edge of the pixel clock to register data.

“A” represents the number of falling clock edges from the rising edge of VSYNC to the rising edge of HSYNC.

“B” represents the number of falling clock edges prior to the first word. (Pre-Scan pixels)

“C” represents the number of words per line.

“D” represents the number of falling clock edges between the last word and the falling edge of HSYNC. (Post-Scan pixels)

“E” represents the number of falling clock edges between a falling HSYNC and a rising HSYNC.

“F” represents the number of falling clock edges from the falling edge of HSYNC to the falling edge of VSYNC

Table 8: HSYNC Pixel Timing

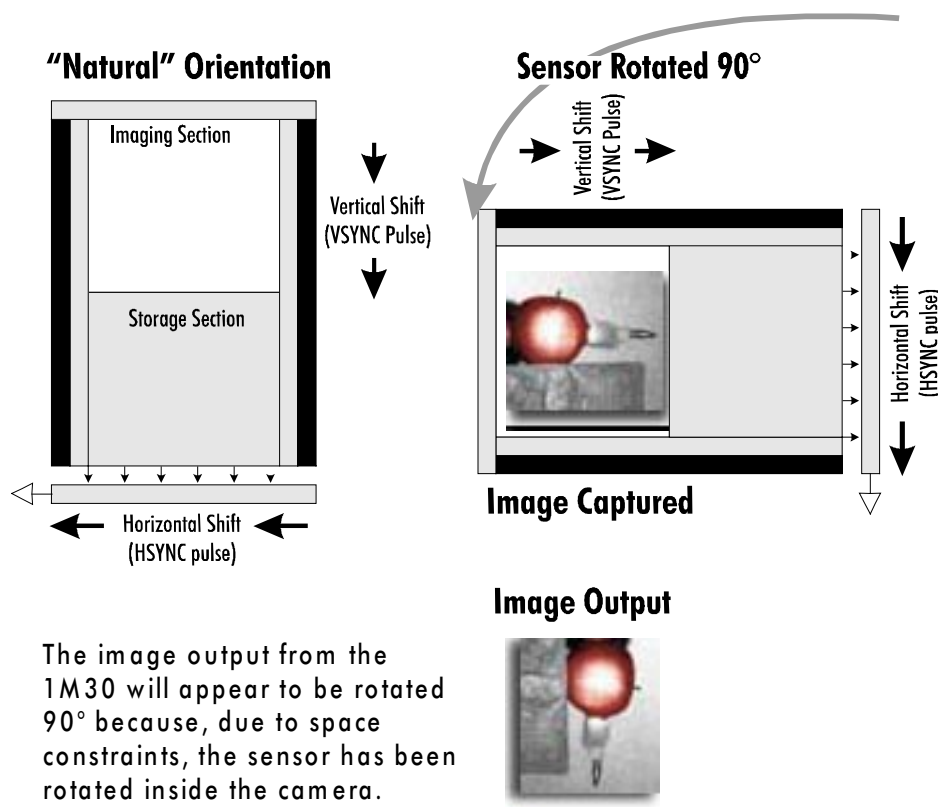
Horizontal Binning Mode	A	B	C	D	E	F
1x	9	28	1024	35	105	2
2x	5	17	512	14	93	1
4x	3	11	256	4	87	0
8x	2	8	127	0	84	0

Table 9: VSYNC Pixel Timing (HSYNC falling edges/VSYNC falling edge)

Vertical Binning Mode	Pre-Scan Lines/Frame	Active Lines/Frame	Post Scan Lines/Frame	Pixel Clock High Width (ns) +/-1.5	Pixel Clock Low Width (ns) +/-1.5
1x	0	1024	6	12.5	12.5
2x	0	512	3	25.0	25.0
4x	0	256	2	25.0	75.0
8x	0	128	1	25.0	175.0

## HSYNC, VSYNC, and Sensor Orientation

It should be noted that due to physical constraints the CCD has been rotated 90 degrees. This must be kept in mind when reconstructing image data from the camera for display or analysis. Although the rotation complicates the sense of “horizontal” and “vertical,” HSYNC still indicates a valid **line**, while VSYNC still indicates a valid **frame**.





## 3

## Camera Operation

### 3.1 How to Control the Camera

The 1M30P's RS-232-compatible serial interface allows you to control its configuration and operation, including:

- Triggering Mode
- Binning
- Frame Rate
- Integration Time
- Gain
- Offset
- Reset

#### Command Protocol Overview

The camera accepts 8-bit command/value pairs via its RJ-11 serial port using RS-232 compatible signals.

Camera commands are divided into two basic sets:

- “clock” commands which apply to the electronics that drive the image sensor. These include clock generation, frame rate, integration time, and binning.
- “ADC” commands which apply to the electronics that process and digitize the video. These include gain and offset.

Each set of commands includes read and write variants. With the exception of reset commands, all 8-bit write commands must be followed by an 8-bit data byte. The commands are interpreted as follows:

Bit	Function
7	Command Recipient 0 = ADC Board 1 = Clock Board

Serial Port Configuration	
Baud	9600, fixed
Start bits	1
Data bits	8
Stop bits	1
Parity	None

Bit	Function
6	Command Type 0 = Write 1 = Read
5:4	Always 00
3:0	Command Register Address (Reference Table 10)



**WARNING:** Any commands not listed should be considered invalid. Writing to invalid addresses may overwrite camera calibration information, requiring the camera to be returned for recalibration.

**WARNING:** Due to initialization sequencing after power-up, no commands should be sent to the camera for a minimum of 1 second after power up.

The following table lists all valid commands available to the user. Any commands not listed should be considered invalid to the 1M30P user.

## 3.2 ADC Commands

Table 10: Summary of ADC Commands

Control	Write Command		Read Command		Function
	Hex	Binary	Hex	Binary	
ADC Board Soft Reset	00h	0000 0000	NA	NA	Resets ADC board only
User Offset	02h	0000 0010	42h	0100 0010	LS byte of 16 bit user controllable offset
	03h	0000 0011	43h	0100 0011	MS byte of 16 bit user controllable offset
User Gain	05h	0000 0101	45h	0100 0101	LS byte of user controllable gain
	06h	0000 0110	46h	0100 0110	MS byte of user controllable gain

## 3.3 Clock Commands

Table 11: Summary of Clock Commands

Control	Write Command		Read Command		Function
	Hex	Binary	Hex	Binary	
Read Camera Type	NA	NA	C3	1100 0011	Reads camera type register (1M30=41h)
Read Firmware Revisions	NA	NA	C5	1100 0101	Reads camera firmware revision
Reset Camera	80h	1000 0000	NA	NA	Resets all registers to default values
Control Register	82	1000 0010	C2	1100 0010	Control Register commands
Binning Register	85	1000 0101	NA	NA	Controls horizontal and vertical binning
Integration Time	8A	1000 1010	NA	NA	LS Byte of an 18 bit Integration Time
	8B	1000 1011	NA	NA	Center Byte of an 18 bit integration time
	8C	1000 1100	NA	NA	MS Byte of an 18 bit integration time
Frame Rate	8D	1000 1101	NA	NA	LS Byte of an 18 bit frame Rate Time
	8E	1000 1110	NA	NA	Center Byte of an 18 bit frame Rate Time
	8F	1000 1111	NA	NA	MS Byte of an 18 bit Frame Rate Time

## 3.4 Control Register Reference

A number of functions and modes depend on the Control Register settings. These settings are detailed in the following sections.

The “Write Control Register” command is used to write a register that controls specific camera triggering and test functions. This command must be followed by a data byte with bits defined as shown in the following table.

The “Read Control Register” command allows interrogation of the camera to determine current configuration of the Control Register.

Table 12: Control Register Bit Definitions

Register	Write Command	Read Command	Bit	Function	Default
Control	82h	C2h	7	Integration Mode 0=Internal 1=External	0
			6:4	Reserved	000
			3	Trigger Mode 0=Internal 1=External	0
			2:1	Reserved	00
			0	Serial Trigger (If Integrate or Trigger Mode=1)	0

## 3.5 Reading the Camera Type

This read command returns an 8-bit value unique to the type of camera interrogated. A 1M30P will return a value of 41h when this command is issued. This is useful for applications that need to function with multiple DALSTAR camera types.

### Example: Read the camera type

	Command	Value Returned (1M30P)
Binary	1100 0011	0100 0001
Hex	C3h	41h

## 3.6 Reading the Firmware Revision

This command returns a byte in which the lower nibble is the revision number for the clock board firmware and the upper nibble is undefined. The ability to read this value may assist in customer support issues.

### Example: Read the firmware version

	Command
Binary	1100 0101
Hex	C5h

## 3.7 Resetting the ADC boards ("soft" reset)

When this command is issued, the microprocessor on the ADC board will jump to the beginning of code and start execution as if the micro was just powered up. This causes

the dark reference control loop to restart at its initial values before settling in to the calibrated dark reference level of approximately 50 counts. This is useful because under some conditions, issuing a soft reset to the ADC board's microprocessor after camera operating conditions have changed will improve the rate at which the offset control loop pulls into the calibrated level.

This is one of only two “write” commands that are not followed by a data byte.

### Example: Reset the ADC board

	Command	Value
Binary	0000 0000	-
Hex	00h	-

## 3.8 Resetting the Camera (“hard” reset)

This is the only other “write” command that is not followed by a data byte. This command resets all clock board registers to their default values (the values used at power-up), and hard re-sets the ADC board microprocessor.

**Table 13: Default values in effect after reset**

Feature	1M30P Default
Frame Rate (fps)	30
Integration Time (ms)	31.1
Resolution (pixels)	1024 x 1024
Video Gain	1x
Binning Mode	1x1
Pixel Offset	50 DN
Synchronization	Free Running
Integration Control	INTERNAL
Data Rate (MHz)	40

### Example: Reset the Camera

	Command	Value
Binary	1000 0000	-
Hex	80h	-

## 3.9 Adjusting Gain

Video gain is adjustable from 1 to 10 by writing a 16 bit value as an MS and LS byte (only the 14 most significant bits of this value are actually used). The value is calculated according to the following equation:

$$\text{Value} \cong 32768 \times \log_{10}(\text{Gain})$$

$$\text{Where } 1 \leq \text{Gain} \leq 10$$

This means that the gain can be adjusted with a resolution of 0.00244dB.

### Example: Set camera to 5x Gain

Use these command/value pairs set the camera to 5x gain (you must write both MSB and LSB values).

$$\text{Value} \cong 32768 \times \log_{10}(5)$$

$$\text{Value} = 22904$$

$$= 5978\text{h}$$

	Write MSB		Write LSB	
	Command	Value	Command	Value
Binary	0000 0110	0101 1001	0000 0101	0111 1000
Hex	06	59	05	78

## Reading Gain from the Camera

To read the gain setting from the camera, use these commands:

	Read MSB	Read LSB
Binary	0100 0110	0100 0101
Hex	46	45

## 3.10 Adjusting User Offset

User offset is adjustable from minus full scale to plus full scale ( $\pm 4095$ ) by a 16 bit value as an MS and LS byte (only the 14 most significant bits of this value are actually used). The value is calculated according to the following equation:

$$\text{Value} \cong 8 \times \text{Offset}/\text{Gain}$$

$$\text{Where Offset is in counts and } -4095 \leq \text{Offset} \leq 4095$$

$$\text{And } 1 \leq \text{Gain} \leq 10 \text{ and is defined as above.}$$

This means that the offset is dependent on the gain and can be adjusted with a resolution of  $0.5 \times \text{Gain}$  (in DN counts).

### Example: Set camera to 200DN Offset @ 5x Gain

Use these command/value pairs set the camera to an offset of 200DN at a gain of 5 (you must write both MSB and LSB values).

$$\text{Value} \cong 8 \times 200/5$$

$$\text{Value} = 320$$

= 0140h

	Write MSB		Write LSB	
	Command	Value	Command	Value
Binary	0000 0011	0000 0001	0000 0010	0100 0000
Hex	03	01	02	40

The read user offset commands allow the user to read back this information from the camera.

## Reading Offset from the Camera

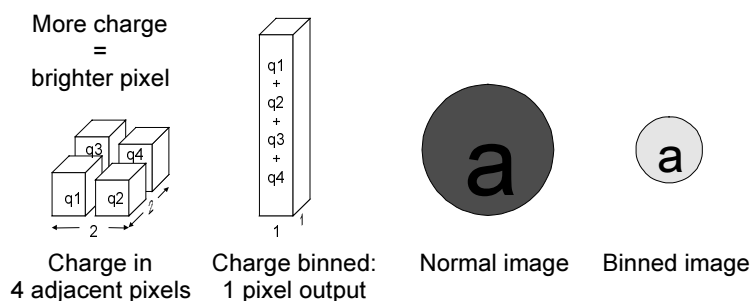
To read the offset setting from the camera, use these commands:

	Read MSB	Read LSB
Binary	0100 0011	0100 0010
Hex	43	42

## 3.11 Controlling Binning

Binning increases the camera's light sensitivity by decreasing horizontal and vertical resolution—the charge collected by adjacent pixels is added together.

### Example: 2x2 Binning



The 1M30P is capable of up to 8x binning in the horizontal and vertical dimension. Horizontal and vertical binning can be controlled independently (e.g. this allows combinations such as 8v x 1h or 2v x 4h). The **default** value for the binning register is 11h (1x1 binning).

To enable binning, you must write a command (85h) to the binning register followed by a data byte that defines how many horizontal and vertical pixels to bin.

The binning command must be followed by a data byte where bits 0 through 2 (H nibble) define the horizontal binning mode and bits 4 through 6 (V nibble) define the vertical binning mode. Bits 3 and 7 are unused. This allows the user to specify any H x V (horizontal by vertical) binning mode combination where H and V range from 1 to 8 independently. The following table specifies H and V values in hex for each mode.

The 1M30P is capable of the following binning modes:

Table 14: Binning Register Definition

H or V nibble	Bit Definition
1h	Associated direction (horizontal or vertical) is binned 1x (unbinned)
2h	Associated direction (horizontal or vertical) is binned 2x
4h	Associated direction (horizontal or vertical) is binned 4x
0h	Associated direction (horizontal or vertical) is binned 8x

### Example: Setting the camera to 2x2 binning mode

H nibble = 2 = 010  
 V nibble = 2 = 010

∴ data byte = 0010 0010

Diagram illustrating the data byte construction for 2x2 binning mode. The H nibble (010) and V nibble (010) are combined to form the data byte 0010 0010. The unused bits are indicated by arrows pointing to the leading zeros.

Write Binning Register with 2x2 mode		
	Command	Value
Binary	1000 0101	0010 0010
Hex	85h	22h

## Lines per image

Vertical binning affects the number of lines per image. Reference section 2.9 – Timing.

## Maximum frame rate

Vertical binning also affects frame rate. Reference section 3.12 – Triggering, Integration, and Frame Rate Overview for specifics.

Whenever the camera is in binning mode, the BIN LED on the right side of the rear cover will light.

## 3.12 Triggering, Integration, and Frame Rate Overview

Image capture triggering, integration, and frame rate are closely related.

- Integration time can be less than  $\lceil 1/(\text{frame rate}) - \text{transfer time} \rceil$ , but it can never be greater.
- You can program fixed integration and frame rates (or use defaults) and let the camera “free run.”
- You can program fixed integration time and supply a (asynchronous) trigger signal to control frame rate, either by toggling a Control Register bit or by supplying a TTL pulse on the SMA connector. This is referred to as “Programmed Integration/External Trigger Mode.”

- You can also have the camera integrate as long as an asynchronous TTL pulse is held high. This pulse will therefore control both integration time and frame rate. This is also known as “External Integrate Mode.”

For a given frame rate, the maximum integration time is limited to the frame period less an overhead factor of 2160  $\mu$ s (transfer time) required for proper operation of the CCD. Maximum integration time is defined by this equation:

$$\text{Max Integration Time} = (1/\text{Frame Rate}) - 2160 \mu\text{s}$$

This equation is valid for all binning modes in free running and external trigger modes.

Note that binning mode impacts the Frame Rate and limits Integration Time.



**WARNING:** Do not set integration time higher than the limits of the equation above. Unpredictable operation may result .

Table 15: Integration/Frame Rate Limits

Vertical Binning	Transfer Time ( $\mu$ S)	Max Frame Rate	Data Rate (MHz)	Maximum Integration Value at Max Frame Rate (ms)	Max Integration Register
1x	2160	30	40	31.173	079C5h
2 x	2160	54	20	16.358	03FE6h
4x	2160	88	10	9.203	023F3h
8x	2160	129	5	5.591	015D7h

The default integration time was chosen to give a frame rate of 30 fps (see section 3.14 *Controlling Frame Rate*).

## 3.13 Controlling Integration (shutter time)

The 1M30P allows you to control integration (also known as exposure time or shutter time) in five ways.

- Programmed Integration/Free Running:** (default) The camera free runs with the internally programmed integration time and frame rate
- Programmed Integration/SMA Trigger:** The camera will integrate for the internally programmed time when triggered by a high going TTL pulse on the SMA connector.
- Programmed Integration/Serial trigger:** The camera will integrate for the internally programmed time when triggered by a high going Serial Trigger signal.
- External Integration/SMA Trigger:** The camera will integrate as long as the TTL pulse on the TRIGGER IN SMA connector is high. The integration time is effectively the input pulse width. In this mode, TRIGGER IN also controls the frame rate.
- External Integration/Serial Trigger:** The camera will integrate as long as the Serial Trigger signal is held high. The integration time is effectively the input pulse width. In this mode, the serial signal also controls the frame rate. Due to variation in the host operating system, this mode is generally used only for camera setup and functional testing.

The register settings required for each mode are defined in the following table.

**Table 16: Integration/Trigger Modes**

Mode	Control Register Bit [7] INTEGRATE	Control Register Bit [3] EXT Trigger
Programmed Integration/Free Running	0	0
Programmed Integration/SMA Trigger	0	1
Programmed Integration/Serial Trigger	0	1
External Integration/SMA Trigger	1	1
External Integration/Serial Trigger	1	1

Whenever the Integrate Mode or External Trigger Mode bits are set the **MODE** LED on the right side of the rear cover will light to indicate that an externally synchronized mode is active.

## Free Running (Programmed Integration):

This mode is the camera's default. The camera integration time is controlled by writing a 3-byte integration time value (in  $\mu\text{s}$ ) to the three Integration Time registers. These three bytes are then combined to form an 18 bit integration time. The number represents the integer number of microseconds the camera will collect light. The number programmed in the three registers should not be below 5  $\mu\text{s}$  (00005h).

The camera's default integration time value is 31.221 ms.

### Example: Set integration time to 10 ms

- Using the command 82h, set bit [7] of the data byte to 0 (Integration Mode = Internal) and bit [3] of the data byte to 0 (Trigger Mode = Internal).

**NOTE:** All bits within the register are written at one time. Ensure the correct value for all bits are used when changing camera modes.

- Use commands 8Ah, 8Bh, 8Ch to set the 18-bit integration time value.

$$\begin{aligned}\text{Value} &= 10 \text{ ms} \\ &= 10000\mu\text{s} \\ &= 02710\text{h}.\end{aligned}$$

	Write Integration LS Byte		Write Integration Center Byte		Write Integration MS Byte	
	Command	Value	Command	Value	Command	Value
Binary	1000 1010	0001 0000	1000 1011	0010 0111	1000 1100	0000 0000
Hex	8Ah	10h	8Bh	27h	8Ch	00h

## Programmed Integration/SMA Trigger

For external SMA controlled triggering with a programmed integration time, a TTL rising edge on the **TRIGGER IN** signal triggers the camera to acquire one frame of data. Integration begins within 200ns after the rising edge and stops when the programmed integration time has completed. After that single frame acquisition, the camera transfers the image to the memory region of the CCD and then outputs the just acquired frame. The camera is “re-armed” when the transfer of the image into the memory region off the CCD is completed. *No additional rising edges, or triggers, should be allowed during the image acquisition or image to memory transfer.*

When the camera is in External Trigger Mode, the MODE LED will be illuminated on the camera back to indicate the camera is expecting a signal on the SMA connector or bit [0] of the Control Register.

Because TRIGGER IN is internally OR'ed with bit[0] of the Control Register, care must be taken to ensure the serial bit [0] of Control Register 1 is not changed from logic 0 to 1 while triggering with the SMA Trigger input.

## Programmed Integration/Serial Trigger

For external serial controlled triggering with a programmed integration time, a TTL rising edge on bit [0] of the Control Register triggers the camera to acquire one frame of data. Integration begins within 200ns after the rising edge and stops when the programmed integration time has completed. After that single frame acquisition, the camera transfers the image to the memory region of the CCD and then outputs the just acquired frame. The camera is “re-armed” when the transfer of the image into the memory region off the CCD is completed. *No additional rising edges, or triggers, should be allowed during the image acquisition or image to memory transfer.*

When the camera is in External Trigger Mode, the MODE LED will be illuminated on the camera back to indicate the camera is expecting a signal on the SMA connector or bit [0] of the Control Register.

Because the serial trigger bit signal is internally OR'ed with the SMA TRIGGER IN, care must be taken to ensure the SMA TRIGGER IN signal is not changed from logic 0 to 1 while triggering with bit[0] of the Control Register.

## External Integration/SMA Trigger

When in External Integration/SMA mode, a TTL rising edge on the **TRIGGER IN** signal triggers the camera to acquire one frame of data. Integration begins within 200 ns after the rising edge and stops within 400 ns after the falling edge. After that single frame acquisition, the camera transfers the image to the memory region of the CCD and then outputs the just acquired frame. The camera is “re-armed” when the image to memory transfer is completed. *No additional rising edges, or triggers, should be allowed during the image acquisition or image to memory transfer.* In this mode TRIGGER IN necessarily controls both integration and frame rate.

When the camera is in External Integration Mode, the MODE LED will be illuminated on the camera back to indicate the camera is expecting a signal on the SMA connector, or bit [0] of the Control Register.

Because TRIGGER IN is internally OR'ed with bit[0] of the Control Register, care must be taken to ensure the serial bit [0] of Control Register 1 is not changed while triggering with the SMA Trigger input.

## External Integration/Serial Trigger

When in External Integration/Serial mode, a TTL rising edge on bit [0] of the Control Register triggers the camera to acquire one frame of data. Due to variation in the host operating system, this mode is generally used only for camera setup and functional testing. Integration begins within 200 ns after the rising edge and stops within 400 ns after the falling edge. After that single frame acquisition, the camera transfers the image to the memory region of the CCD and then outputs the just acquired frame. The camera is “re-armed” when the image to memory transfer is completed. *No additional rising edges, or triggers, should be allowed during the image acquisition or image to memory transfer.* In this mode serial bit [0] of the Control Register necessarily controls both integration and frame rate.

When the camera is in External Integration Mode, the MODE LED will be illuminated on the camera back to indicate the camera is expecting a signal on the SMA connector or bit [0] of the Control Register.

Because the serial trigger bit signal is internally OR'ed with the SMA TRIGGER IN, care must be taken to ensure the SMA TRIGGER IN signal is not changed while triggering with bit[0] of the Control Register.

## 3.14 Controlling Frame Rate

The 1M30P allows you to control frame rate in three ways.

- **Free Running (Programmed Frame Rate):** (default) The camera free runs with the internally programmed frame rate time and integration time.
- **External Trigger/Internal Integration:** The camera frame rate will be controlled by the TTL pulse on the TRIGGER IN SMA connector or serial bit [0] of the Control Register. The camera will integrate for the programmed integration time. (*Reference section 3.13 Controlling Integration Mode*)
- **External Integration:** The camera frame rate will be controlled by the TTL pulse on the TRIGGER IN SMA connector or serial bit [0] of the Control Register. The camera will integrate for as long as the pulse is held high. In this mode, TRIGGER IN also controls integration. (*Reference section 3.13 Controlling Integration Mode*)

### Free Running (Programmed Frame Rate)

This mode is the camera's default. To specify programmed frame rate, you must set bit [7] of register 1 to 0 (Integrate Mode = Internal), and bit [3] of register 1 to 0 (Trigger Mode = Internal). Next, write the 3-byte frame rate value (in  $\mu$ s or 1/Frame Rate) to the three Frame Rate registers. These three bytes are then combined to form an 18 bit frame rate time. (Note that only the least significant 2 bits of the Frame Rate Time MS byte are valid

in the 18 bit Frame Rate value) The number represents the integer number of microseconds between frames. The number programmed in the three registers should not be below 5  $\mu$ S (00005h), nor above the calculated value noted in section 3.12 *Triggering, Integration, and Frame Rate Overview*.

### Example: Set the Frame Rate to 5.0 fps

1. Reference section 3.12 Triggering, Integration, and Frame Rate Overview to ensure the desired frame rate can be supported for the selected binning and integration modes.
2. Using the command 82h, set bit [7] of the data byte to 0 (Integration Mode = Internal) and bit [3] of the data byte to 0 (Trigger Mode = Internal).

NOTE: All bits within the register are written at one time. Ensure the correct value for all bits are used when changing camera modes.

3. Use commands 8Dh, 8Eh, 8Fh to set the 18-bit Frame Rate time value.

$$\begin{aligned}\text{Value} &= 1/5.0\text{s} \\ &= 200000\mu\text{s} \\ &= 30\text{D}40\text{h}\end{aligned}$$

	Write Frame Rate LS Byte		Write Frame Rate Center Byte		Write Frame Rate MS Byte	
	Command	Value	Command	Value	Command	Value
Binary	1000 1101	0100 0000	1000 1110	0000 1101	1000 1111	0000 0011
Hex	8Dh	40h	8Eh	0Dh	8Fh	03h

## External Trigger/Programmed Integration

This is the same as External Integrate/SMA Trigger Mode. Reference to section 3.13 Controlling Integration Mode.

### Example: Set the Frame Rate to 2.5 fps

1. Reference section 3.12 Triggering, Integration, and Frame Rate Overview to ensure the desired frame rate can be supported for the selected binning and integration modes.
2. Using the command 81h, set bit [0] of the data byte to 0 (Integration Mode = Internal) and bit [3] of the data byte to 1 (Trigger Mode = External).

NOTE: All bits within the register are written at one time. Ensure the correct value for all bits are used when changing camera modes.

3. Set the desired integration time per section 3.13 – Controlling Integration.
4. Each TTL rising edge on the SMA connector will initiate a new frame of data, using the programmed integration time. To achieve 2.5 fps, a TTL pulse must be sent to the camera every 400 ms (1/2.5).

## External Integration

This is the same as External Integration Modes described in section 3.13 Controlling Integration Mode.



## 4.2 Mechanical Tolerances

Table 17: Mechanical Tolerances

Additional Dimensions	
Center of sensor with respect to lens mount	<.025"
Planarity of lens flange to sensor	<.010"
Rotation of sensor	<.3°

## 4.3 Mounting the Camera

The 1M30P can be mounted via the 3/8" deep, 1/4"-20 threaded tripod mount located on the bottom of the camera.

# 5

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## Cleaning and Maintenance

### 5.1 Cleaning

#### Electrostatic Discharge and the CCD Sensor

Charge-coupled device (CCD) image sensors are metal oxide semiconductor (MOS) devices and are susceptible to damage from electrostatic discharge (ESD). Although many sensor pins have ESD protection circuitry, the ESD protection circuitry in CCDs is typically not as effective as those found in standard CMOS circuits.

Electrostatic charge introduced to the sensor window surface can induce charge buildup on the underside of the window that cannot be readily dissipated by the dry nitrogen gas in the sensor package cavity. When charge buildup occurs, surface gated photodiodes (SGPDs) may exhibit higher image lag. Some SGPD sensors may also exhibit a highly non-uniform response when affected by charge build-up, with some pixels displaying a much higher response when the sensor is exposed to uniform illumination. The charge normally dissipates within 24 hours and the sensor returns to normal operation.

#### Preventing ESD Damage

**Note:** The ESD handling precautions are not applicable to part number DS-14-01M30.

To prevent ESD damage, DALSA advises you to take the following handling precautions.

1. Ground yourself prior to handling CCDs.
2. Ensure that your ground and your workbench are also properly grounded. Install conductive mats if your ground or workbench is non-conductive.
3. Use bare hands or non-chargeable cotton gloves to handle CCDs. NOTE: Rubber fingercoats can introduce electrostatic charge if the rubber comes in contact with the sensor window.
4. Handle the CCD from the edge of the ceramic package and avoid touching the sensor pins.
5. Do not touch the window, especially in the region over the imaging area.

6. Ground all tools and mechanical components that come in contact with the CCD.
7. DALSA recommends that CCDs be handled under ionized air to prevent static charge buildup.
8. Always store the devices in conductive foam. Alternatively, clamps can be used to short all the CCD pins together before storing.

The above ESD precautions need to be followed at all times, even when there is no evidence of CCD damage. The rate which electrostatic charge dissipates depends on numerous environmental conditions and an improper handling procedure that does not appear to be damaging the CCDs immediately may cause damage with a change in environmental conditions.

## Protecting Against Dust, Oil, and Scratches

The CCD window is part of the optical path and should be handled like other optical components, with extreme care.

Dust can obscure pixels, producing dark patches on the sensor response. Dust is most visible when the illumination is collimated. The dark patches shift position as the angle of illumination changes. Dust is normally not visible when the sensor is positioned at the exit port of an integrating sphere, where the illumination is diffuse.

Dust can normally be removed by blowing the window surface using clean, dry, compressed air, unless the dust particles are being held by an electrostatic charge, in which case either an ionized blower or wet cleaning is necessary.

Oil is usually introduced during handling. Touching the surface of the window barehanded will leave oily residues. Using rubber fingercoats and rubber gloves can prevent contamination. However, the friction between rubber and the window may produce electrostatic charge that may damage the sensor. To avoid ESD damage and to avoid introducing oily residues, only hold the sensor from the edges of the ceramic package and avoid touching the sensor pins and the window.

Improper handling, cleaning or storage of the sensor can cause scratches. Vacuum picking tools should not come in contact with the window surface. CCDs should not be stored in containers where they are not properly secured and can slide against the container.

Scratches diffract incident illumination. When exposed to uniform illumination, a sensor with a scratched window will normally have brighter pixels adjacent to darker pixels. The location of these pixels will change with the angle of illumination.

## Cleaning the Sensor Window

1. Use clean, dry, compressed air to blow off loose particles. This step alone is usually sufficient to clean the sensor window.
2. If further cleaning is required, use a lens wiper moistened with alcohol.
3. We recommend using lint free, ESD safe cloth wipers that do not contain particles that can scratch the window.
4. Wipe the window carefully and slowly.

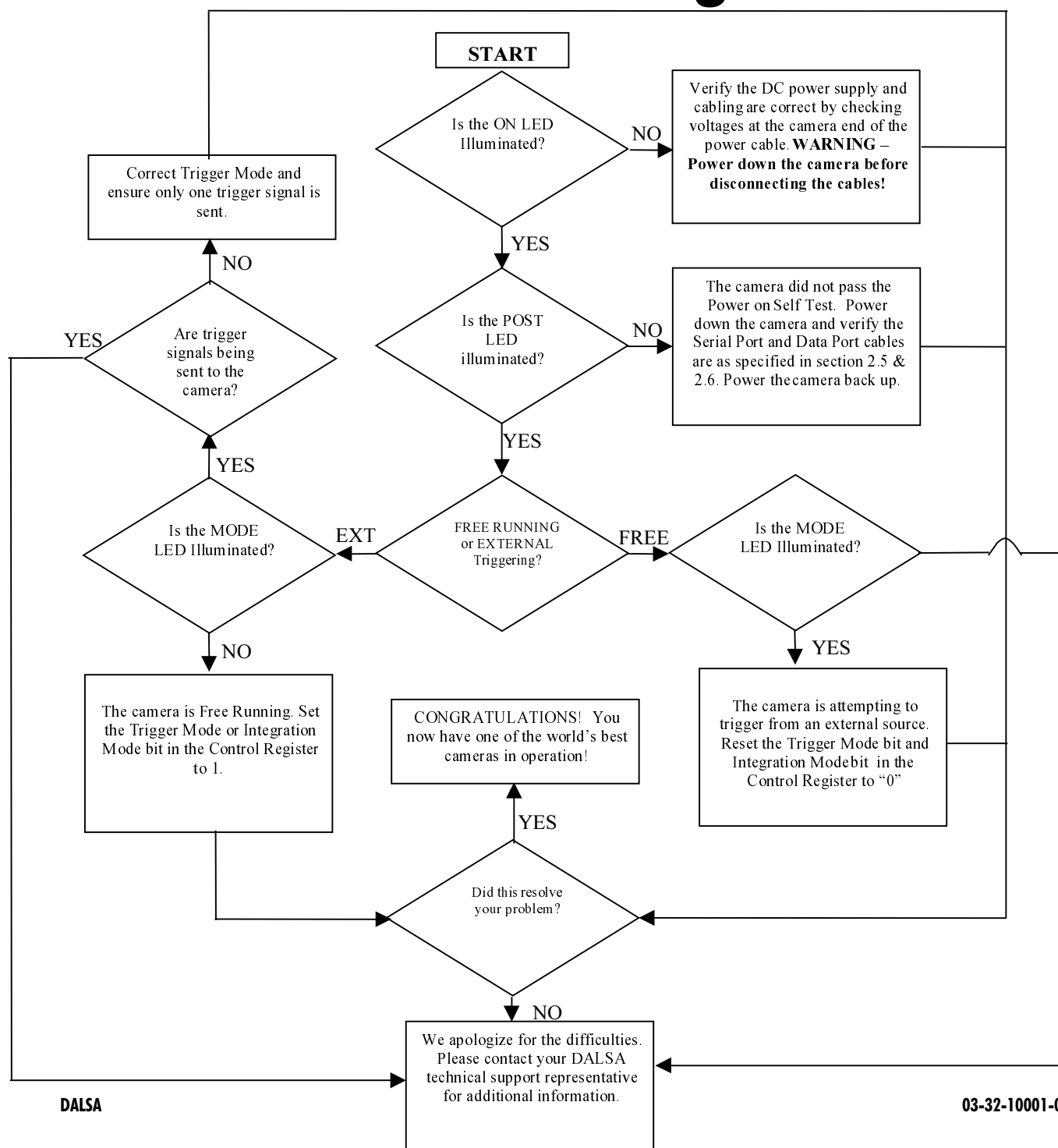
## 5.2 Maintenance

There are no user serviceable parts on this camera. Please contact DALSA service.



## 6

# Troubleshooting





# 7

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## Warranty

### 7.1 Limited One-Year Warranty

#### What We Do

This product is warranted by DALSA for one year from date of original purchase. Please refer to your Purchase Order Confirmation for details.

#### What is Not Covered

This warranty does not apply if the product has been damaged by accident or misuse, or as a result of service or modification by other than DALSA, or by hardware, software, interfacing or peripherals not provided by DALSA. DALSA shall have no obligation to modify or update products once manufactured. This warranty does not apply to DALSA Software Products.

**Note:** If the camera has a non-standard cover glass (part number DS-14-01M30) the warranty is void on the CCD.

#### How to Obtain Service for Your Equipment

If you want to return your product for repair, contact DALSA Customer Service in order to obtain a Return Goods Authorization form. Repair cannot begin until the form is issued, completed, and returned to DALSA

##### **DALSA Technical Support**

Phone: 519 886 6000  
Fax: 519 886 8023  
email: [support@DALSA.com](mailto:support@DALSA.com)



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